

DOI: 10.15608/iccc.y2016.547

CLIMATE CHANGE, ENVIRONMENTAL CONDITIONS AND HEALTH: LESSONS LEARNED FROM THE PAST CENTURIES

OEDOJO SOEDIRHAM*

*Faculty of Public Health, Universitas Airlangga Campus C UNAIR,
FKM Jl. Mulyorejo, Surabaya 60115*

ABSTRACT

The relationship between overall environment - social and physical - and human health status is not new. As Galvao et al. (2009) said that climate change, urbanization, rural development, agriculture and food security are intertwined determinants of population health and health equity. Since the existence of human civilization both of these have been proven to have a very close relationship and mutual influence. History of the cholera outbreak in mid 19th century discovered in London by John Snow is one proof that environment affects the health of mankind. Likewise, human behavior is also crucial circumstances surrounding environment, both locally and globally.

People experiences the genesis interaction between nature and human beings that are not favorable either direct or indirect more often today. Direct incidence of natural disasters eg floods, landslides are a few of the many events that are not desired by anyone. Genesis indirectly eg changes in the nature of disease vectors because of changes in the physical environment that complicate its eradication.

This paper will critically discuss the relationship between the environment and human health from the beginning of human civilization until now hoped to remind us all to always pay attention to the environment when people will make innovations to meet their needs.

Keywords: climate change, overall environment, human health status, human civilization.

1 BACKGROUND

Climate change affects health via a cascade of different mechanisms. (Fig. 1) Direct effects are diseases and deaths as a result of extreme weather events like heat, flooding, mudslides, storms, and hurricanes. Indirect effects are those that result from changes in the ecosystem, such as conditions that facilitate infectious diseases, changes in agricultural production, and the availability of (clean) water. But climate change can also have indirect effects on health from the social and economic turmoil brought on by drought, flooding, famine, epidemics and movement of refugees (IPPC 2007). In public health discipline, one of the classical evidence of the impact of environmental conditions on health is the history of cholera outbreak that discovered in London by John Snow. This paper will critically discuss the relationship between climate change, the environmental conditions and cholera outbreaks from the beginning of human civilization until the present time.

* Corresponding author and Presenter: Email: oedojo@yahoo.com

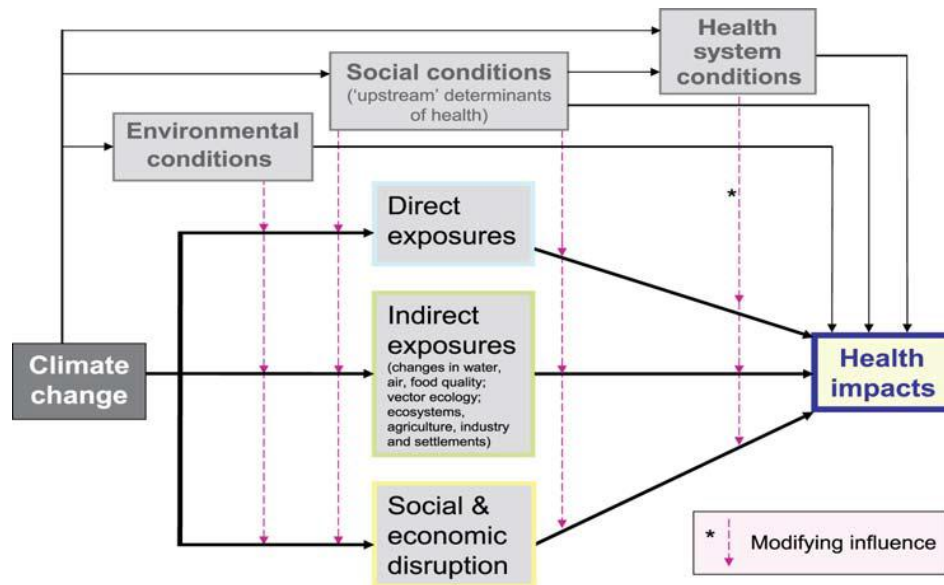


Fig. 1. Mechanisms of climate change affecting health (IPCC 2007)

2 WATERBORNE DISEASES AND SANITATION

The relationship between human health and climate is not a new concept, nor is it a new subject. In fact at least as far back as Hippocrates, many believed that human health was intricately linked to the seasons, local weather patterns, and other environmental factors. While preceding the advent of Pasteur's germ theory in the mid-1800s, these notions described certain patterns of disease, and often therapies were based directly on changes in the environment. Proponents of miasma, i.e., a poisonous atmosphere arising from swamps and putrid matters, as a source of disease noted that fevers and intestinal ailments were common in warm seasons and were often associated with wet, poorly drained, and humid areas, such as swamps. This association motivated draining of swamps in rural areas and the installation of the first central sewer systems in urban areas in North America. Of course, the therapeutic benefits of these practices had little to do with ridding the environment of miasma, but these practices did reduce the size and number of habitats breeding mosquitoes (disease vectors) and removed raw waste (hence, waterborne pathogens) from immediate contact with humans. In spite of the developments in the mid- the to late 1800s demonstrating the role of microorganisms in disease, the theory of weather-borne diseases held firm in early medicine until the late 1800s. Clearly, the relationship between climate and health has been a subject of study for a very long time (Ford et al. 2009; Lipp et al. 2002).

Water and climate go hand in hand, with precipitation and extreme events known to be associated with waterborne outbreaks. Flooding is the most frequent natural weather disaster (30%–46% of natural disasters in 2004–2005), affecting >70 million persons worldwide each year (data for 2005 [5]). The most common illnesses associated with

floods described in the literature are diarrhea, cholera, typhoid, hepatitis (jaundice), and leptospirosis (Ford et al. 2009).

The quality and quantity of drinking water, irrigation water, and environmental and/or recreational waters can be associated with changes in environmental conditions including weather- or climate-related variables. Floods may cause the overflow of wastewater treatment plants, failure of septic systems, or combined sewer overflows, which could contaminate nearby surface waters or wells. Furthermore, there is increasing concern about pathogens in stormwater runoff. Maintaining sanitary water conditions is also an issue during drought conditions, when contaminants may become concentrated in available water. Additionally, the likelihood of multiple uses in a water body may increase (e.g., for cleaning, bathing, and drinking) during droughts and consequently enhance the risk of contamination and exposure (Lipp et al. 2002).

3 THE CHOLERA STORY AND JOHN SNOW

Among waterborne disease, cholera has proven one of the history's most virulent killers. Cholera is an infection of the small intestine caused by the bacterium *Vibrio cholerae*. Cholera is transmitted primarily by drinking water or eating food that has been contaminated by the cholera bacteria. The bacteria multiply in the small intestine; the feces (a waste product) of an infected person, including one with no apparent symptoms, can pass on the disease if it contacts the water supply by any means (Awofeso 2004; Epstein 1992).

History does not recount any incidents of cholera until the 19th century. Cholera came in seven waves, the last two of which occurred in the 20th century. When the second cholera epidemic hit England in 1854, Snow described it as "the most terrible outbreak of cholera which ever occurred in this kingdom." At least it provided him with an opportunity to test his theory. By charting the incidence of the disease, he showed that over 500 cases occurred within 10 days over a radius of some 250 yards centered on London's Broad Street. He looked for some poison which he believed came from the excreta of cholera patients and swallowed by the new victims. A common factor was their use of water from the Broadstreet pump (Awofeso 2004; The British Library Board n.d.; Epstein 1992).

4 CLIMATE CHANGE AND CHOLERA

Burke et al. (2016) said that humans have been adapting to environmental change for millennia, surviving ice ages, droughts and plagues. Over some 12,000 years of the Holocene epoch, the levels of climate-warming carbon dioxide in the atmosphere remained relatively stable, as did Earth's temperature. Sedas (2007) further confirms that anthropogenic climate change is measurably affecting ecosystems, communities, and populations. Diverse environmental factors influence the distribution, diversity, incidence, severity, and/or persistence of diseases and other health issues - something that has been

recognized for millennia. Health and climate have been linked since antiquity. In the fifth century B.C., Hippocrates observed that many specific human illnesses were linked to changes of season, local weather patterns, and other environmental factors such as temperature.

But as the industrial revolution in the 20th century accelerated growth in population, economic activity, technology and pollution, human activities began to alter the planet's life-support systems. The scale and permanence of those impacts are such that geologists are now dating a new epoch to around 1950, calling it the Anthropocene to signify that *Homo sapiens* have pushed the Earth's natural systems into disequilibrium, moving greenhouse gas accumulations beyond levels considered safe for humanity's biologic and social well-being (Burke et al. 2016; Hancock and Duhl 1986; Kenzer 1999).

Accordingly, Dekker (2014) said that the environments in which people live play a role in their health, as such, changes to their environments will influence their health, positively or negatively. Climate change has been a negative influence on the environment, and human health is being adversely affected by it. Moreover, research conducted by the WHO (2006) and other research bodies such as the Lancet has shown that climate change adversely impacts human health in numerous ways; from contributing to the re-emergence of diseases, to the spread of infectious diseases and increased mortality. The mechanisms by which climate change impact human health are as diverse and complex as the impacts. There is no clear causal pathway between a climate change impact, such as air pollution and a health issue such as asthma; rather it is a series of pathways. Climate change impacts, namely, air pollution and air quality, extreme temperatures, extreme weather, and rising sea levels and flooding, do not express themselves independently of each other. Trærup et al. (2011) emphasized that increased temperatures and changes in rainfall patterns as a result of climate change are widely recognized to entail potentially serious consequences for human health, including an increased risk of diarrheal diseases. There are complex and interconnected relationships between each for example high temperatures increase the concentration of pollutants in the air thereby degrading air quality. Consequently, the relationship between climate change and health is complex; moreover, the range of factors that influence health are complex too.

As CCC (2009) and Pascual et al. (2002) recorded that growing concerns over the effects of climate change and environmental deterioration are driving current interest in the influence of climate on disease dynamics especially the resurgence of many old infectious diseases. The importance of climatic factors, however, is controversial because of the many human and socioeconomic determinants, even for vector-borne diseases such as malaria with well-established relations between weather and transmission capacity. Climate and disease associations in the past have lacked quantitative support, certainly for cholera and other diseases with less consensus on environmental drivers. The unprecedented and growing

availability of climate data from remote sensing and reanalysis, as well as developments in the forecasting of climate variability, present new opportunities for retrospective analysis and epidemic forecasting.

The current evidence of the impact of climate on the epidemiology of the waterborne disease is considered under three headings; the impact of heavy rainfall events, the impact of flooding and the impact of increased temperature (Hunter 2003). One of the infectious diseases that are dangerous to humans and its transmission dynamics closely related to climate change is cholera. Studies about the impact of climate change on cholera vulnerability are reported from everywhere (Wandiga 2006). Lugomela (2014) added more information that *Vibrio cholerae*, which causes the acute enteric infection of cholera, is essentially a marine bacterium, with coastal waters acting as an important reservoir. The bacterium has been found in coastal environments around the world, both in areas where cholera is endemic and in cholera disease-free areas. It is now well known that cholera occurs in regions with natural aquatic reservoirs

Pascual et al. (2008) added the information that cholera outbreaks in endemic regions exhibit both seasonality and interannual variability, with significant differences in size from year to year. There has been a long history of trying to explain these interannual cycles, the period of which varies from 3 to 8 yr, based on associations with climate. The reemergence of cholera in Peru in 1991 to 1992, after the absence of the disease in South America for almost a century, which coincided with an El Niño event, motivated the hypothesis that the El Niño Southern Oscillation (ENSO) is a driver of cholera dynamics.

Studies about the impact of climate change on cholera vulnerability are reported from everywhere. Reported by Wandiga (2006) that in East Africa, a cholera epidemic was first reported in 1836; this was constrained along the Indian Ocean coast, killing as many as 20,000 people in Zanzibar alone, and almost depopulated the coastal towns of Lamu, Malindi, and Kilwa. Lee (2001) further said that cholera remains one of the most feared infectious diseases in public health. It is an acute bacterial infection of the intestine caused by the ingestion of food or water contaminated by certain strains of the *Vibrio cholerae* organism. *V. cholerae* produces enterotoxins (toxins which act in the gastrointestinal tract) whose actions on the mucosal epithelium is responsible for the characteristic symptoms of the disease, namely acute watery diarrhea and vomiting. In the most severe cases, cholera is one of the most rapidly fatal illnesses known, due to severe dehydration or water loss. If left untreated, mortality from “classical” cholera can be 50%. A healthy person may become hypotensive within an hour of the onset of symptoms and may die within 2-3 hours although more usually death may come within a day or so.

According to CCC (2009), Koelle (2009), Lee (2001) and Project SD/AR/04A (2015) human induced changes in the global climate and associated sea level rise are widely

accepted by policy makers and scientists. Summarized by IPCC (Inter-Governmental Panel on Climate Change) 2007 summary, surface air warming in the 21st century (best estimates for the low scenario) is 1.80C with a range of 1.1°C to 2.9°C. It is broadly accepted that Bangladesh is one of the most vulnerable countries that would be affected by the adverse impact of climate change because of its geographical position as well as vulnerable socio-economic condition. Cholera is one of a number of infectious diseases that appears to be influenced by climatic changes. Climate change influences the epidemiology of cholera, as cholera is a water-borne disease, the changes of various bio-physicochemical parameters of water e.g. temperature, salinity, pH, an abundance of phytoplankton have an impact on distribution and survival of *Vibrio cholerae*, the causative agent of cholera. After the discovery of phytoplankton as a reservoir of cholera remote sensing data has shown that cholera epidemics in Bangladesh can be predicted by monitoring phytoplankton bloom in the Bay of Bengal.

5 CONCLUSION

The review of some references proves that the impact of climate change on health human and the environment has been happening since the beginning of civilization. The relationship indicates that if the harmony is disturbed it will be unwanted hazardous happens. And unfortunately, the disorder often caused by the action of a human being in the name of development.

It is evident that climate change has an impact on human health. While it is a challenge to identify the exact casual pathways that link climate change to negative health outcomes, as they are infinite and complex, the impacts cannot be ignored. All stakeholders must work collaboratively to create policies that will mitigate the vulnerabilities to human health that are posed by climate change. As such the social determinant of health provide a starting point from which innovative and active policy can be developed to mitigate climate change and improve human health simultaneously (Dekker 2014).

Significant association of cholera incidence with local climatic variables (rainfall and tide) and biological factors (Phytoplankton) has been observed. Significant increase in temperature, rainfall, humidity and tidal height may influence the incidence of cholera (CCC 2009). Further, the temperature has been detectable as the 'agent of change' for transmission dynamics of cholera out of changing climatic parameters. The last eighteen years data on temperature and cholera showed that the cholera epidemic has a relation with shifting of temperature from higher to lower during postmonsoon cholera season and lower to higher during pre-monsoon cholera season (CCC 2009; Lipp et al. 2002; Lugomela 2014; Project SD/AR/04A 2015). Lipp et al. (2002) and Wandiga (2006) added that *V. cholerae* has long been known as a fecal-oral pathogen, and indeed, infection rates are significantly greater in areas with poor sanitation, lack of clean drinking water; however, the evidence

showing that *V. cholerae* is naturally present in warm, brackish environments is overwhelming. Public perception and awareness of extreme weather events and disease are among the critical factors determining the prevention and adaptive capacity of individuals and communities to the impact(s) of climate-sensitive diseases such as cholera.

Finally, Lee (2001) and Sedas (2007) reminds that cholera remains among those infectious diseases posing a potentially serious threat to public health systems around the world in the twenty-first century. Since 1991 around 120 countries have reported indigenous cases of cholera, nearly half of those countries during at least five of the last eight years. It is a recurring problem in many areas and has become endemic in others. Cholera illustrates many of the increased health risks associated with the global changes taking place around us-large scale movement of people, changes to ecosystems from heavy pollution, human-induced climate change, rapid technological change, and economic and political instability. Widening socioeconomic inequalities within and between countries leaves over one billion people without access to clean water and 1.7 billion people with no access to sanitation services. The lessons learned in industrialized countries from the great pandemics of the nineteenth century have not yet been applied to the world as a whole. While the biology of cholera is among the best understood of that of infectious diseases, there is much that we still don't know. Cholera are recognized as more complicated and durable than previous thought, possibly existing permanently within the environment rather than only living a few days outside of the human intestine. The relationship between the organism and environmental conditions continues to be a subject of keen debate (Galvao 2009).

Further Sedas (2007) said that the persistence of *V. cholerae* as part of the normal flora in aquatic environments, the lack of an effective vaccine, and increasing antibiotic resistance among strains isolated from cholera patients all suggest that cholera will not be eradicated in the future. As with other tropical diseases, there is growing concern that the combination of climate change, anthropogenic disturbance of local environments, and transport due to travel and trade will expand the range of endemic strains, and consequently, create more focal points for cholera outbreaks. As socioeconomic conditions favorable to cholera persist in many countries, revealing the influence of climatic/environmental factors in seasonal patterns is critical to understanding the temporal variability of cholera at longer time scales, including trends and interannual variability to improve disease forecasting. An understanding of disease risk related to the environment can also call attention to the need for improving these conditions (WCED, 1987; WHO, 2006). A complete understanding of the ecology of *V. cholerae* is critical to identify and comprehend the seasonality and regional mechanisms as a function of environmental factors for the prediction and management of this disease. Trærup et al. (2011) and Burke et al. (2016) affirm that integrating both climate variables and socioeconomic variables in one model confirms that

conditions of human health are influenced by many factors and cannot be addressed in isolation.

REFERENCES

- Awofeso, N. (2004). What's New About the "New Public Health"? May 2004, Vol 94, No. 5 | American Journal of Public Health.
- Burke, K. S., D. C. Chapman Walsh, and M. Barry (2016). Discussion Paper September 2016. Health: The Human Face of Climate Change: Perspective and Recommendations for the Next U.S. President. Prepared for The Climate Implementation Project Conference Series. Stanford Center for Innovation in Global Health Stanford University School of Medicine 291 Campus Drive Stanford, CA 94305. The British Library Board (n.d.). The British Library Board.
- CCC, 2009. Climate change and its impact on transmission dynamics of cholera. Climate Change Cell, DoE, MoEF; Component 4b, CDMP, MoFDM. Month 2009, Dhaka
- Dekker, Sabrina (2014). Climate Change and Social Determinants of Health: Innovating Climate Policy. ICCG Reflection No. 19/February 2014.
- Epstein, Paul R. (1992). Cholera and The Environment: An Introduction to climate Change. *The PSR Quarterly*, September 1992, vol 2 no.3 pp 146-160.
- Ford, Timothy E., Rita R. Colwell, Joan B. Rose, Stephen S. Morse, David J. Rogers, and Terry L. Yates (2009). Using Satellite Images of Environmental Changes to Predict Infectious Disease Outbreaks | Emerging Infectious Diseases • www.cdc.gov/eid • Vol. 15, No. 9, September 2009.
- Galvao, L.A.C., et al. (2009). "Climate change and social determinants of health: two interlinked agendas". Global Health Promotion. Supp 16:81-84.
- Hancock, T and Duhl, L. (1986). *Healthy cities promoting health in the urban context*. Copenhagen, WHO Regional Office for Europe, 1986.
- Hunter, P.R. 2003. Climate change and waterborne and vector-borne disease. *Journal of Applied Microbiology* 2003, 94, 37S–46S.
- IPPC, Intergovernmental Panel on Climate Change, Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, 2007.
http://www.ipcc.ch/publications_and_data/ar4/wg2/en/contents.html
- Koelle, K (2009). The impact of climate on the disease dynamics of cholera *European Society of Clinical Microbiology and Infectious Diseases*, CMI, 15 (Suppl. 1), 29–31.
- Kenzer, Marina (1999). Healthy cities: a guide to the literature. *Environment and Urbanization*, Vol. 11, No. 1, April 1999
- Lee, Kelley (2001). The global dimensions of cholera, Global Change & Human Health, Volume 2, No. 1 (2001) 6.
- Lipp, Erin K., Anwar Huq, and Rita R. Colwell (2002). Effects of Global Climate on Infectious Disease: the Cholera Model, *Clinical Microbiology Reviews*, Oct. 2002, p. 757–770 Vol. 15, No. 4 0893-8512/02/\$04.000 DOI: 10.1128/CMR.15.4.757–770.2002,
- Lugomela, C., Thomas J. Lyimo, Lucy A. Namkinga, Sabrina Moyo, Ralf Goericke and Sara Sjöling (2014). Co-variation of Cholera with Climatic and Environmental Parameters in Coastal Regions of Tanzania. *Western Indian Ocean J. Mar. Sci. Vol. 13. No. 1*, pp. 93 - 105, 2014 © 2015 WIOMSA
- Pascual, M, M. J. Bouma and A. P. Dobson (2002). Cholera and climate: revisiting the quantitative evidence. *Microbes and Infection* 4 (2002) 237–245
- Pascual, M, L. F. Chaves, B. Cash, X. Rodó, Md. Yunus (2008). Predicting endemic cholera: the role of climate variability and disease dynamics. *CLIMATE RESEARCH Clim Res* Vol. 36: 131–140, 2008
doi: 10.3354/cr00730

- Project SD/AR/04A (2015). *Cholera outbreaks at Lake Tanganyika induced by Climate Change? - "CHOLTIC"*. Final Report. Brussels: Belgian Science Policy 2015 - 117 p. (Research Programme Science for a Sustainable Development).
- Sedas, Violeta T. P. (2007). Influence of environmental factors on the presence of *Vibrio cholerae* in the marine environment: a climate link. *J Infect Developing Countries* 2007; 1(3):224-241.
- Trærup , Sara L. M., Ramon A. Ortiz and Anil Markandya (2011). The Costs of Climate Change: A Study of Cholera in Tanzania, *Int. J. Environ. Res. Public Health* 2011, 8, 4386-4405; doi:10.3390/ijerph8124386
- United Nations Environment Programme (2016). Healthy Environment, Healthy People. Thematic report. Ministerial policy review session. Second session of the United Nations Environment Assembly. of the United Nations Environment Programme. Nairobi, 23–27 May 2016.
- Wandiga, Shem O. (2006). Climate Change Induced Vulnerability to Malaria and Cholera in the Lake Victoria Region, A Final Report Submitted to Assessments of Impacts and Adaptations to Climate Change (AIACC), Project No. AF 91, Kenya National Academy of Sciences, Nairobi, Kenya. Published by The International START Secretariat 2000 Florida Avenue, NW Washington, DC 20009 USA.
- WCED (World Commission on Environment and Development) (1987). The World Commission on Environment and Development (also known as the Brundtland Commission): *Our Common Future*.
- WHO (2006). Preventing disease through healthy environments. Towards an estimate of the environmental burden of disease. World Health Organization.